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On the steam-assisted cooking of beef: Effect of steam injection level (#348)

Ruihong Feng[1, 2], Yulong Bao[2], Peng Zhou[1, 2]

[1] Jiangnan University, School of Food Science and Technology, Wuxi, China; [2] Jiangnan University, State Key laboratory of Food Science and Technology, Wuxi, China

Introduction

In recent years, consumers have been paying more and more attention to food safety and nutrition. Steam-assisted cooking of meat has been reported to be beneficial due to many aspects, such as reduce the cooking time, produce juicy meat, reduce the amount of salt and oil in the meat, avoid forming too much hazardous chemicals at very high temperatures, etc. Steam-assisted oven has gradually emerged in domestic cooking and it can be used for preparing of a wide range of meals. This study aims to explore the effect of steam injection level on the cooking conditions (temperature and humidity) within the oven, and their effects on meat quality.

Methods

Beef sirloins purchased from a local supermarket were used for the present study. Meat pieces (2 cm thick, equilibrated at room temperature) were cooked to a center temperature of 71 ℃ in an oven (C906, Robam Ltd., Hangzhou, China) at 200℃ under natural convection (NC), NC with low steam injection level (NC/LS), and NC with high steam injection level (NC/HS), respectively. The LS/HS was achieved by injecting steam every 5 min / 2 min. During cooking, center temperature of meat, dry bulb and wet bulb temperature of the oven were recorded. The wet bulb and dry bulb temperatures were used to estimate the relative humidity of the oven, through the Magnus equation: $P = P_0 * 10^{(7.45T/(235+T))}$. Where P is the saturation pressure of water vapor at temperature T (℃); P_0 is the saturation pressure of water vapor at 0℃ (0.611 kPa). The relative humidity was calculated as $P_{\text{wet bulb}}/Pd_{\text{ry bulb}}$ *100%. The method for estimating relative humidity has been validated under 100℃, where relative humidity can be measured directly.

Shear force and chewiness were measured by texture analyzer (TA.XT2) equipped with HDP/BSK blade. Shear test was performed with trigger value at 20.0 g, pre-test speed at 2 mm/s, test speed at 1.5 mm/s and post-test speed at 10 mm/s.

Tukey test was used to find the significant difference at $P = 0.05$ level with IBM SPSS software (V20).

Results

Temperature profile was recorded and showed in Fig. 1. At high steam injection level, center temperature of beef samples increased rapidly, while no clear difference was found between NC and NC/LS. After around 11 min, NC/HS group reached endpoint temperature of 71℃, while NC group required a cooking time of 17 min. Steam injection had a negative impact on the oven temperature. Adding low amount of steam greatly increased the wet bulb temperature, which is believed to be more important for the cooking of food. At most of the time during cooking, food surfaces are wet and hence the temperature will be close to wet bulb temperature. Increased steam had a further impact on increasing the wet bulb temperature.

The dry bulb and wet bulb temperatures were used to calculate the relative humidity within the oven, by applying the Magnus equation (Fig. 2). Under NC, relative humidity increased throughout cooking process, mainly due to the evaporation of meat juice. Under NC/HS and NC/LS, it was as expected that humidity increased, and we can clearly see the fluctuation of relative humidity due to the injection of steam.

Both NC/LS and NC/HS increased the shear force and chewiness of cooked beef as compared to NC ($P < 0.05$). However, no difference was found between NC/LS and NC/HS. The effect of steam on shear force and chewiness in the present study appeared to be contradictory to some previous papers, further studies are undertaken to answer this question.

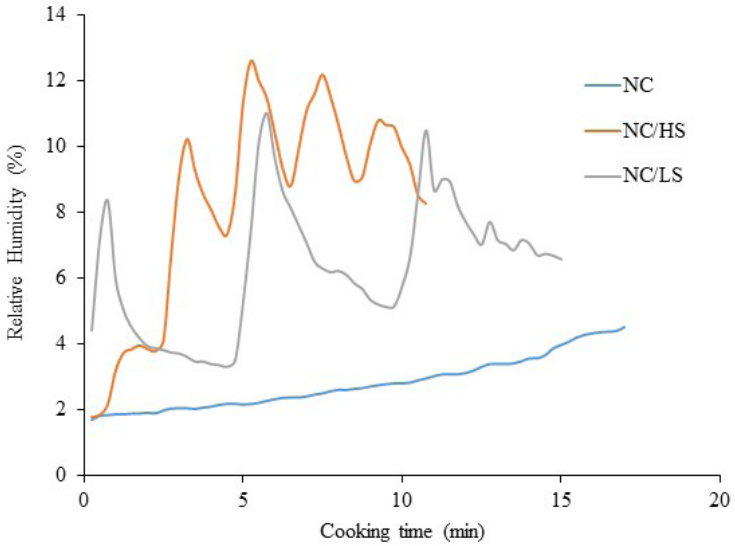
Conclusion

Steam-assisted cooking greatly affected the temperature and humidity profile within the oven. Preliminary results showed that shear force and chewiness were increased when steam was injected to the oven.

Group	Shear force (g)		Chewiness (kg*sec)	
	Mean	S.D.	Mean	S.D.
NC	5666a	658	16a	3
NC/LS	7361b	345	23b	2
NC/HS	7878b	1075	26b	5

Table 1. Shear force and chewiness of cooked beef sirloin. NC, natural convection; NC/HS, natural convection with high steam; NC/LS, natural convection with low steam.

Notes



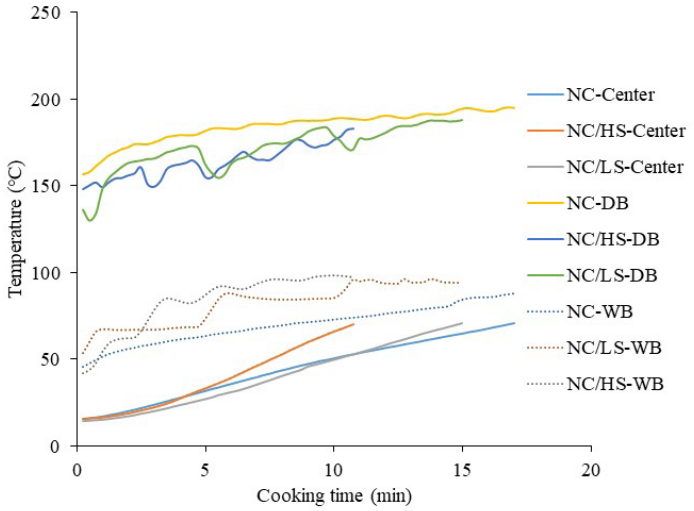


Figure 1. Temperature changes during cooking of beef sirloin
NC, natural convection; NC/HS, natural convection with high steam; NC/LS, natural convection with low steam; Center, the center temperature of beef sample; DB, dry bulb temperature; WB, wet bulb temperature.

Fig. 2. Relative humidity (%) changes during cooking of beef sirloin.
NC, natural convection; NC/HS, natural convection with high steam; NC/LS, natural convection with low steam.

Notes